

Early zoeas of *Athanas parvus* De Man, 1910 (Decapoda: Caridea: Alpheidae) reared in the laboratory

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Abstract.—Early zoeas of *Athanas parvus* De Man are described and illustrated in detail, based on laboratory-hatched eggs from females collected in Sangju, Korea. This is the first record of the genus *Athanas* Leach from Korean waters. The zoeal characteristics of *Athanas* species are compared with those of species of the other four alpheid genera for which larvae are known. Based on morphological similarity, larval characters of *Athanas* species support a close relationship between the Alpheidae and Palaemonidae.

The small shrimps of the genus *Athanas* Leach, 1814 are usually found in dead coral heads, pools under rocks, and sandy or muddy beaches. Some species are found in permanent association with sea urchins, living between the spines on the oral surface (Banner & Banner 1973). Ten species of the family Alpheidae, belonging to four genera have been recorded from Korean waters (Yang & Anker 2003). However, species of the genus *Athanas* have not been reported from Korean waters to date.

Larvae of three species of *Athanas* have been described so far: *A. djiboutensis* Coutière, 1897, first zoea obtained from Ghardaqa (Gurney 1938); *A. dimorphus* Ortmann, 1894, first zoea based on plankton material from the Red Sea (Gurney 1927) and first three zoeal stages from India (Bhuti et al. 1977); and *A. nitescens* (Leach, 1814), first three zoeal stages from the U.K. (Lebour 1932), and other descriptions based on plankton material (Sars 1906, Williamson 1915, Webb 1921, Kurian 1956, Bourdillon-Casanova 1960, Williamson 1967).

This study describes and illustrates in detail the early zoeal stages of *A. parvus* De Man, 1910, and compares morphological characteristics of the zoea of species of

Athanas with those of the other four alpheid genera for which larvae are known.

Material and Methods

On 21 July 1997, ovigerous females of *Athanas parvus* were collected from oyster raft cultures in Sangju, Korea (34°43'00"N, 127°59'30"E). Ten newly hatched zoeas were removed and placed in each of six glass bowls containing 33.3‰ filtered seawater, and kept in a growth chamber at 25°C. Larvae were fed daily with the microalga *Dunaliella tertiolecta* Butcher, and some specimens in each stage were preserved in 7% neutral formalin. Drawings were made with the help of a camera lucida. Measurements and setal counts were based on the mean of ten specimens for each zoeal stage. Total length (TL) was measured from the rostral tip (postorbital margin for the first zoea) to the posteromedian margin of the telson, excluding posterior setae. Carapace length (CL) was measured from the postorbital margin to the posteromedian margin of the carapace. The setal armature of appendages is described from proximal to distal segments. The chromatophore pattern was determined by observation of living zoeas.

Results

Four zoeal stages were obtained. When the fourth zoea molted to the fifth zoea, the larvae died because of their inability to extricate themselves from the fourth zoeal exoskeleton. The first zoeal stage is described in detail, and for subsequent stages only main differences from previous stage are given.

First zoea

Fig. 1

Duration. 18–20 hours.

TL. 1.38 (1.26–1.46) mm; CL. 0.26 (0.24–0.32) mm.

Carapace (Fig. 1A). Rostrum absent; anterior dorsomedian papilla present; pterygostomial spine present; supraorbital and antennal spines absent; anteroventral and posteroventral denticles absent; eyes sessile.

Antennule (Fig. 1C). Peduncle unsegmented; inner flagellum with long plumose seta; outer flagellum with 3 aesthetascs, short plumose seta, and long simple seta.

Antenna (Fig. 1D). Peduncle with basal spine; endopod spine-like, less than one-third length of scale; scale 4-segmented, with 11 plumose setae and distolateral spine.

Mandibles. Rudimentary.

Maxillule (Fig. 1E). Coxal endite with subterminal seta and 3 terminal setae; basal endite with 2 stout spines and short subterminal seta; endopod segmented, with 2 terminal setae.

Maxilla (Fig. 1F). Coxal endite with 2 setae; basal endite bilobed, with 3 + 4 setae; endopod with 3 (1 basal + 2 terminal) setae and fine marginal hairs; scaphognathite with 5 plumose setae.

First maxilliped (Fig. 1G). Coxa with seta; basis unarmed; endopod segmented, with 3 terminal setae; exopod with 4 terminal natatory setae.

Second maxilliped (Fig. 1H). Coxa unarmed; basis unarmed; endopod 4-segment-

ed, with 0, 0, 1, 3 setae; exopod with 4 terminal natatory setae.

Third maxilliped (Fig. 1I). Coxa unarmed; basis with simple seta; endopod 4-segmented, with 0, 0, 2, 2 setae; exopod with 5 (1 subterminal + 4 terminal) natatory setae.

Pereiopods (Fig. 1J). Pereiopod 1 biramous; pereiopods 2–4 absent; pereiopod 5 uniramous.

Abdomen (Fig. 1A). Composed of 5 somites, sixth somite not differentiated; all somites without spines; third somite bent; third to fifth somites with pairs of dorso-median setae; pleopods absent.

Telson and uropods (Fig. 1B). Telson subtriangular, with 7 + 7 marginal setae; outermost 2 pairs plumose only on inner side; bases of all setae except outermost with row of minute spinules. Uropods visible.

Chromatophores (Fig. 1A). Dark red chromatophores present on peduncles of antennule and antenna, superolateral margin of each eye, anterior dorsomedian papilla of carapace, ventral margin of carapace, dorsolaterally on carapace, bases and exopods of first, second, and third maxillipeds, endopod of third maxilliped, rudiments of pereiopods 1 and 5, dorsally on second to fifth abdominal somites, ventrally on first and fourth to fifth abdominal somites, and telson. Yellow chromatophores present on peduncle of antennule and laterally on second and third abdominal somites.

Second zoea

Fig. 2

Duration. 1–2 days.

TL. 1.53 (1.52–1.54) mm; CL. 0.28 (0.26–0.32) mm.

Carapace (Fig. 2A, B). Rostrum short, not extending beyond eyes; eyes stalked.

Antennule (Fig. 2D). Peduncle 2-segmented, with 3 and 4 setae.

Antenna (Fig. 2E). Unchanged.

Mandibles (Fig. 2F). Palp absent; left and

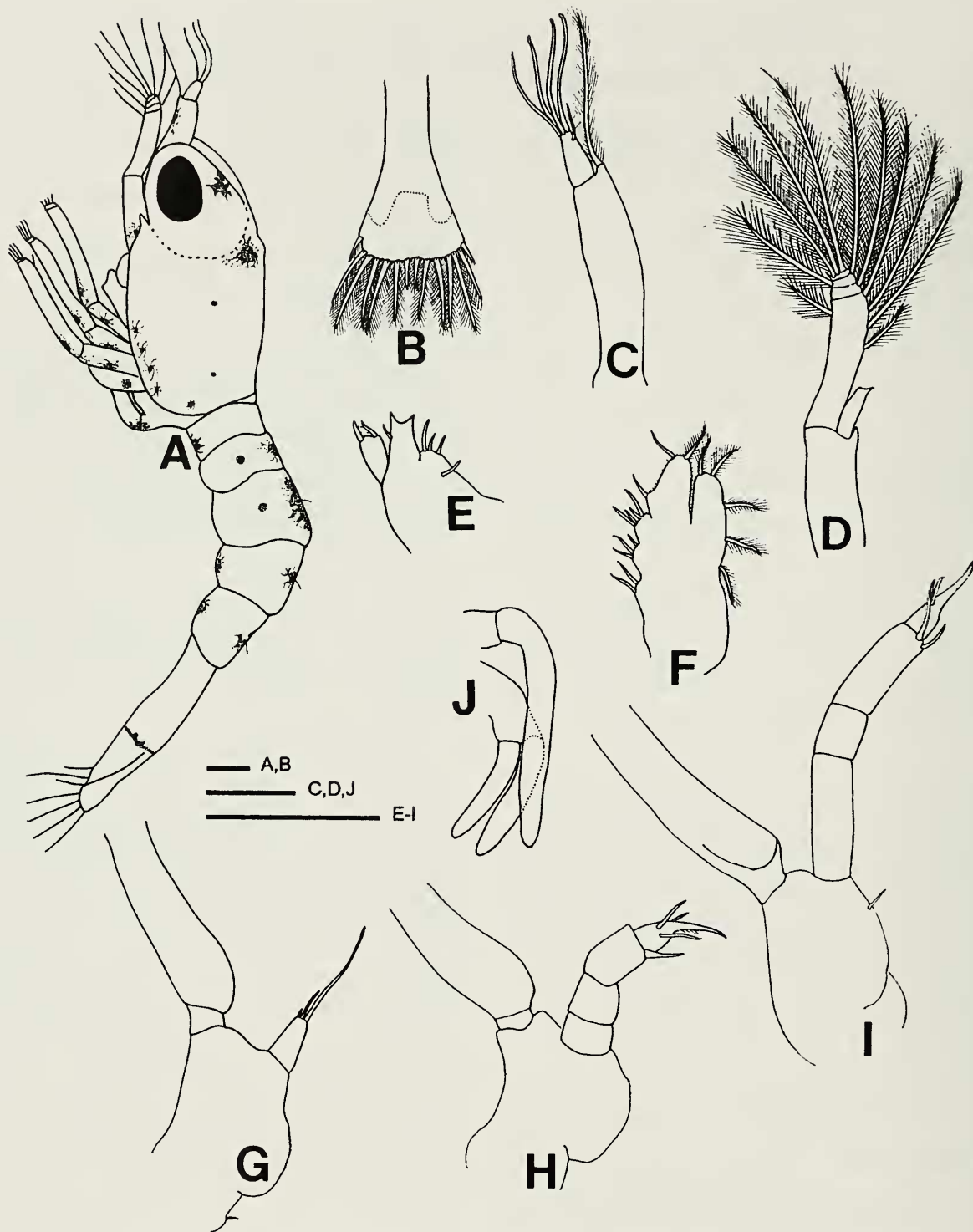


Fig. 1. First zoea of *Athanas parvus* De Man, 1910. A, habitus, lateral view; B, telson and uropods, dorsal view; C, antennule; D, antenna; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped; J, pereiopods 1 and 5. Exopod shown truncated in G-I. Scale bars = 0.1 mm.

right mandibles without spine between molar and incisor processes.

Maxillule (Fig. 2G). Coxal endite with 5 setae; basal endite with 2 spines and 2 setae.

Maxilla (Fig. 2H). Unchanged.

First maxilliped (Fig. 2I). Unchanged.

Second maxilliped (Fig. 2J). Basis with

2 small marginal spiniform setae; endopod 5-segmented, with 0, 0, 0, 1, 3 setae.

Third maxilliped (Fig. 2K). Unchanged.

Pereiopods (Fig. 2L). Pereiopods 1 and 5 longer; pereiopod 2 biramous as bud; pereiopod 3 uniramous.

Abdomen (Fig. 2A, B). Unchanged.

Telson and uropods (Fig. 2C). Telson

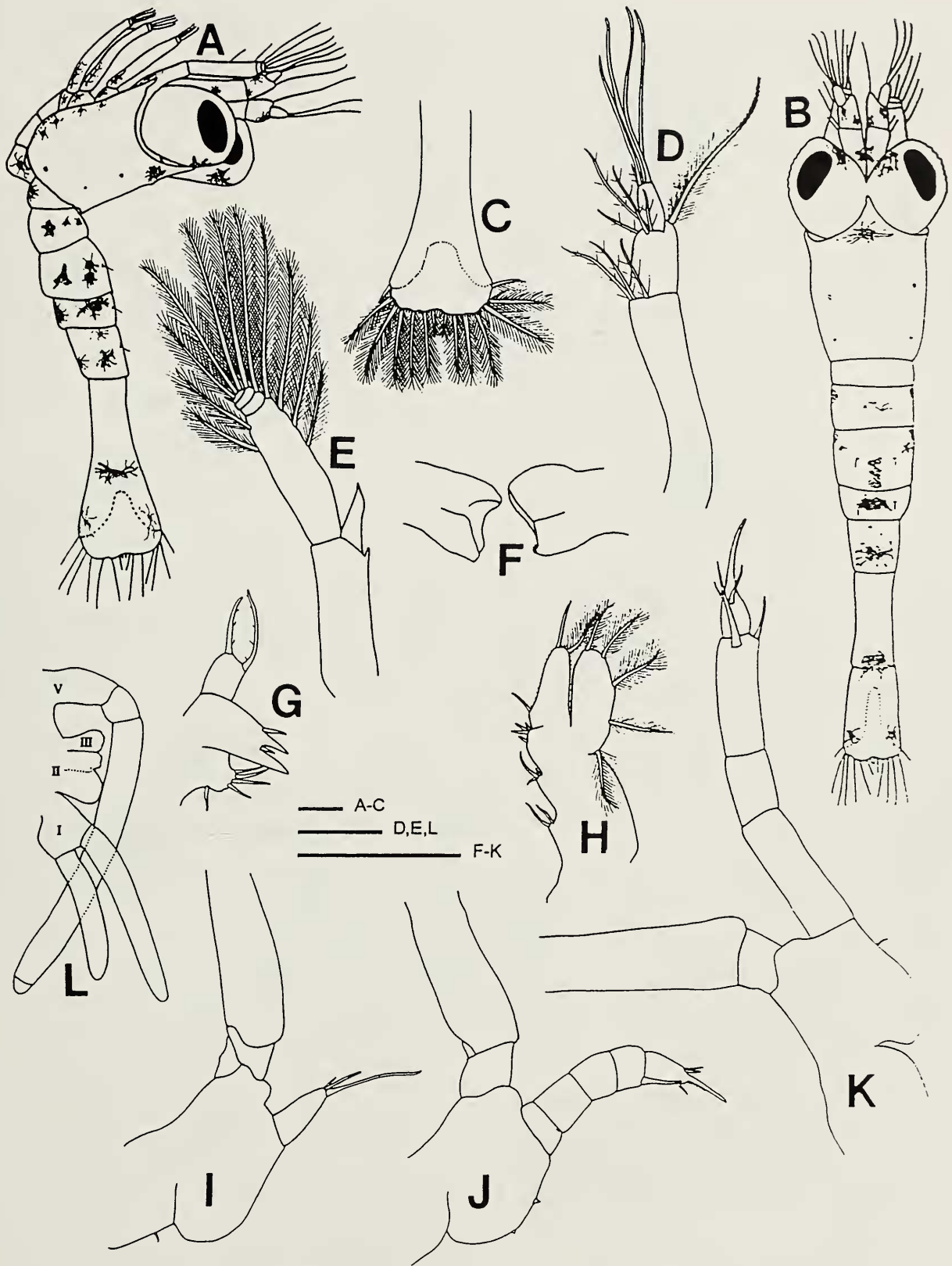


Fig. 2. Second zoea of *Athanas parvus* De Man, 1910. A, habitus, lateral view; B, habitus, dorsal view; C, telson and uropods, dorsal view; D, antennule; E, antenna; F, mandibles; G, maxillule; H, maxilla; I, first maxilliped; J, second maxilliped; K, third maxilliped; L, pereiopods 1-3 and 5. Exopod shown truncated in I-K. Scale bars = 0.1 mm.

with 8 + 8 marginal setae; outermost pair plumose only on innerside. Uropods unchanged.

Third zoea
Fig. 3

Duration. 2–3 days.

TL. 1.60 (1.56–1.62) mm; CL. 0.29 (0.28–0.32) mm.

Carapace (Fig. 3A, B). Rostrum longer.

Antennule (Fig. 3D). Peduncle with 8 and 6 setae.

Antenna (Fig. 3E). Scale 2-segmented.

Mandibles (Fig. 3F). Left mandible with 2 spines (lacinia mobilis) between molar and incisor processes; right mandible with spine at corresponding site.

Maxillule (Fig. 3G). Unchanged.

Maxilla (Fig. 3H). Unchanged.

First maxilliped (Fig. 3I). Unchanged.

Second maxilliped (Fig. 3J). Unchanged.

Third maxilliped (Fig. 3K). Unchanged.

Pereiopod 1 (Fig. 3L). Basis with simple seta; endopod 4-segmented, with 0, 0, 2, 1 setae; exopod with 4 terminal natatory setae.

Pereiopods 2–3. Unchanged.

Pereiopod 5 (Fig. 3L). Endopod 5-segmented, with 0, 0, 0, 0, 1 setae; dactylus elongated, sharply pointed, with 4 distal denticles facing mouthparts.

Abdomen (Fig. 3A, B). Sixth somite now differentiated from telson; posterolateral margin acute.

Telson and uropod (Fig. 3C). Telson with 7 + 7 marginal setae; posterior width slightly greater than anterior width. Uropod free: endopod rudimentary; exopod with 6 plumose setae.

Fourth zoea
Fig. 4

Duration. 3–4 days.

TL. 1.65 (1.62–1.67) mm; CL. 0.34 (0.27–0.36) mm.

Carapace (Fig. 4A, B). Unchanged.

Antennule (Fig. 4D). Proximal segment of peduncle with 10 plumose setae; outer

flagellum with 3 aesthetascs, 2 plumose setae, and simple seta.

Antenna (Fig. 4E). Unchanged.

Mandibles (Fig. 4F). Unchanged.

Maxillule (Fig. 4G). Unchanged.

Maxilla (Fig. 4H). Basial endite with 4 + 5 setae.

First maxilliped (Fig. 4I). Unchanged.

Second maxilliped (Fig. 4J). Unchanged.

Third maxilliped (Fig. 4K). Basis with 2 setae; endopod 5-segmented, with 0, 0, 0, 2, 2 setae.

Pereiopod 1 (Fig. 4L). Basis with 2 simple setae.

Pereiopods 2–4. Unchanged.

Pereiopod 5 (Fig. 4M). Unchanged.

Abdomen (Fig. 4A, B). Unchanged.

Telson and uropod (Fig. 4C). Telson narrower, with 4 + 4 marginal setae; posterior width slightly narrower than anterior width. Uropod developed: endopod with 8 plumose setae; exopod with 12 plumose setae.

Discussion

There are larval descriptions for 17 species in seven genera of Alpheidae from the Indo-West Pacific (Yang & Kim 2002). The larval descriptions of *Alpheopsis garricki* Yaldwyn, 1971 and *Betaeopsis aequimanus* (Dana, 1852) (see Packer 1985) are not sufficiently informative for comparisons. However, useful comparison of early zoeas is possible between the remaining genera: *Alpheus* Fabricius, 1798, *Athanas*, *Automate* De Man, 1888, *Synalpheus* Bate, 1888, and *Vexillipar* Chace, 1988. The zoeas of species of these latter five genera can be distinguished from each other by the setation of the endopods of the maxillule, the maxilla, and the second maxilliped. In zoeas of species of *Athanas*, *Alpheus*, and *Vexillipar*, the endopod of the maxilla has 1 + 2 setae, while in those of *Automate* and *Synalpheus* the endopod is furnished with 0 + 4 and 2 + 3 setae, respectively. Zoeas of species of *Athanas* are readily distinguished from those of *Alpheus* and *Vexillipar* by having two setae on the endopod of the maxillule,

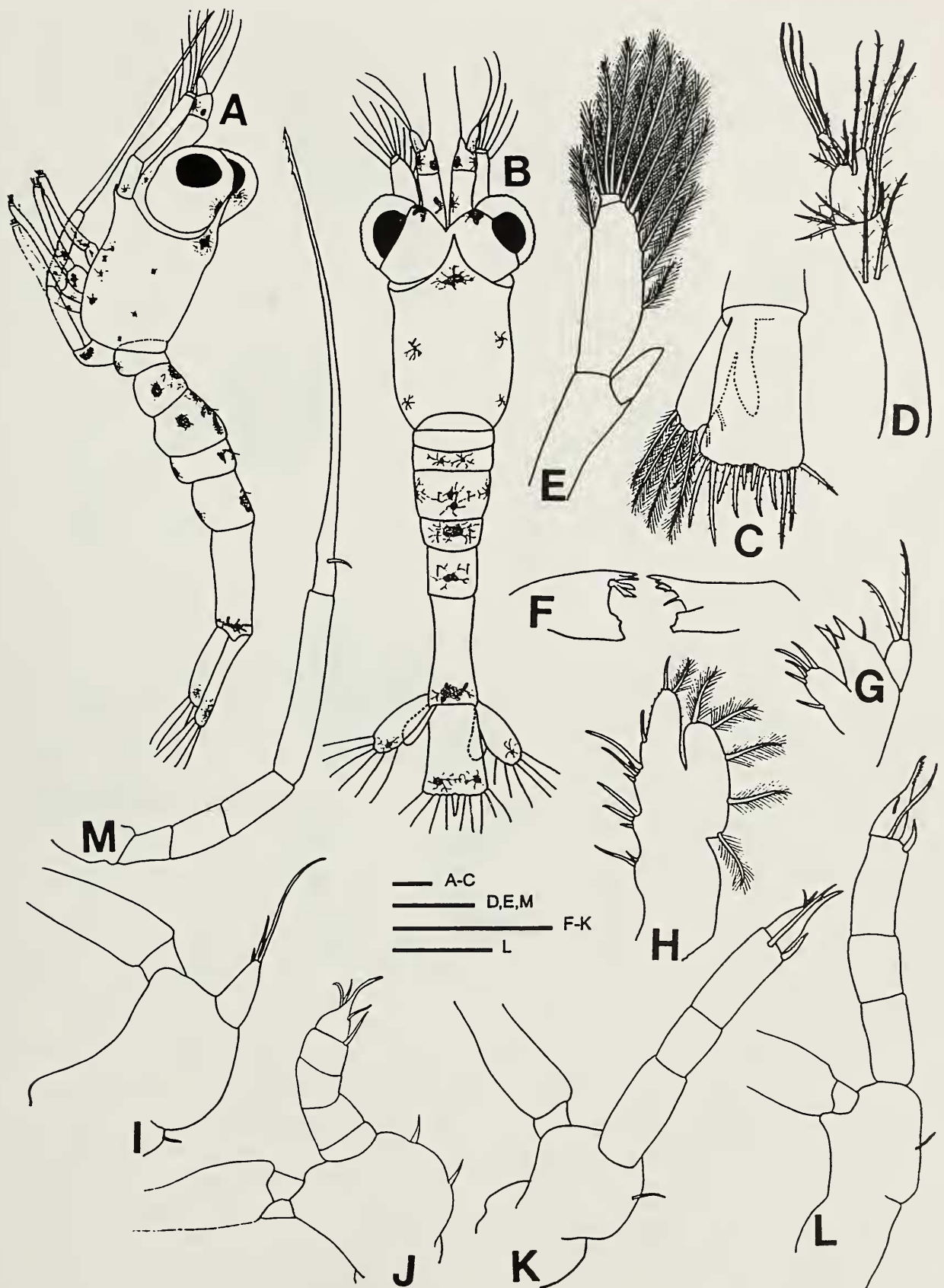


Fig. 3. Third zoea of *Athanas parvus* De Man, 1910. A, habitus, lateral view; B, habitus, dorsal view; C, telson and uropod, dorsal view; D, antennule; E, antenna; F, mandibles; G, maxillule; H, maxilla; I, first maxilliped; J, second maxilliped; K, third maxilliped; L, pereopod 1; M, pereopod 5. Exopod shown truncated in I-L. Scale bars = 0.1 mm.

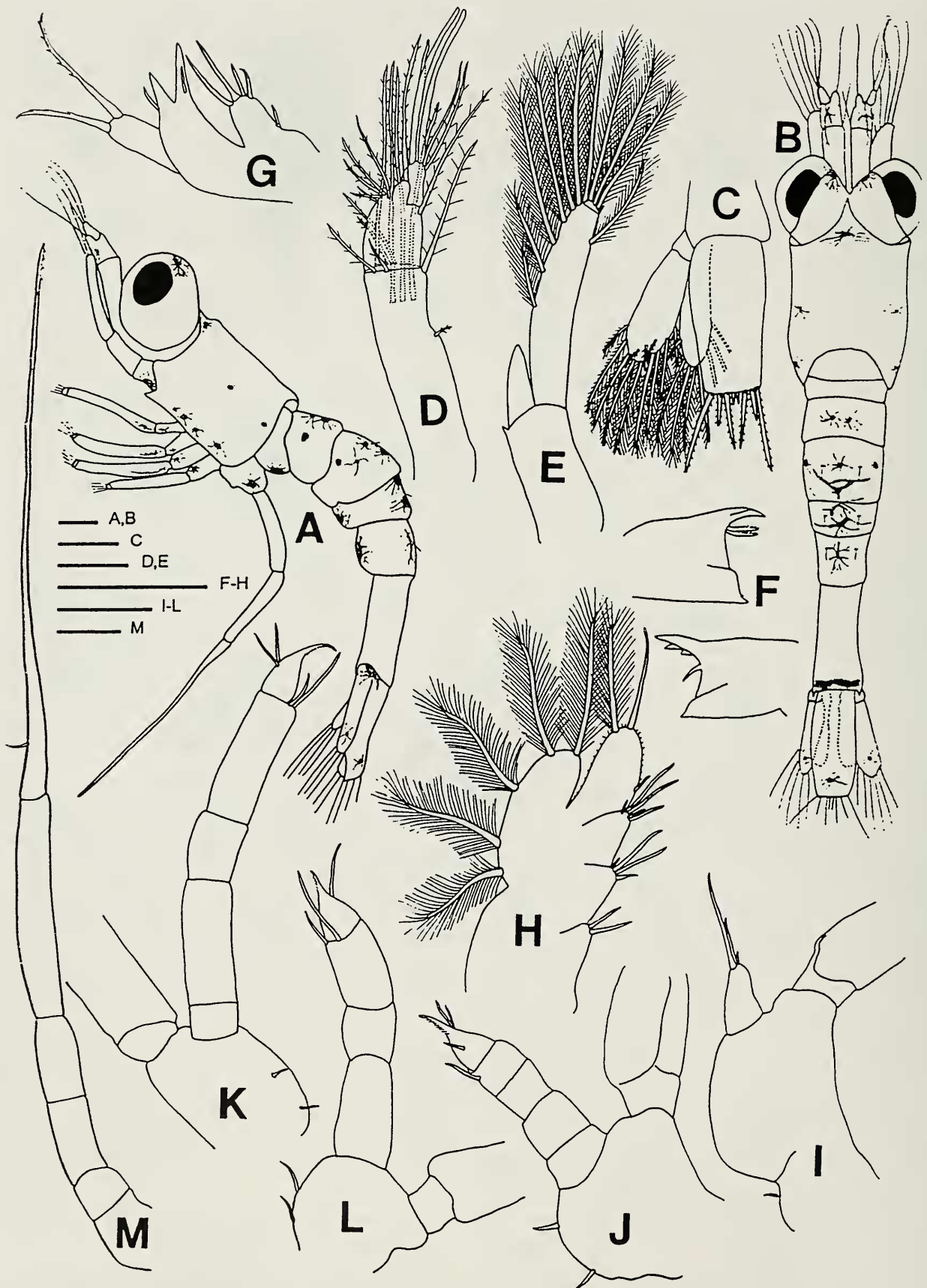


Fig. 4. Fourth zoea of *Athanas parvus* De Man, 1910. A, habitus, lateral view; B, habitus, dorsal view; C, telson and uropod, dorsal view; D, antennule; E, antenna; F, mandibles; G, maxillule; H, maxilla; I, first maxilliped; J, second maxilliped; K, third maxilliped; L, pereiopod 1; M, pereiopod 5. Exopod shown truncated in I-L. Scale bars = 0.1 mm.

and an unarmed proximal segment of the endopod of the second maxilliped.

Lebour (1932) pointed out that the differences between the larvae of *Athanas* and *Alpheus* were the length of the dactylus of the endopod of the third maxilliped in the second zoea, and the number of the exopods of the pereopods in later stage zoeas. The dactylus of the endopod of the third maxilliped in the second zoea of *Athanas dimorphus* Ortmann, 1894 (see Bhuti et al. 1977), *A. parvus* (present study), and *Synalpheus tumidomanus* (Paulson, 1875) (see Bhuti et al. 1977) is never elongated; in species of *Alpheus* the dactylus is long, although it becomes short in the third zoea (see Yang & Kim 2002). The second zoea of *Betaeus truncatus* Dana, 1852 and *B. emarginatus* (H. Milne Edwards, 1837) (see Albornoz & Wehrtmann 1997) has the dactylus of the endopod of the third maxilliped elongated. The length of the dactylus of the endopod of the third maxilliped is, therefore, an important character of the second zoea distinguishing the larvae of *Athanas* and *Synalpheus* from those of *Alpheus* and *Betaeus*. However, it is not possible at this time to distinguish the second zoea of *Athanas* from that of *Automate dolichognatha* De Man, 1888 (see Bhuti et al. 1977) and *Vexillipar repandum* Chace, 1988 (see Saito et al. 1998) because larval descriptions of both species are limited to the first stage.

Except for *Periclimenes pandionis* Holthuis, 1951, larvae of the Alpheidae and the Palaemonidae are characterized by both the lack of a proximal endite on the maxilla, and the lack of an outer seta on the base of the maxillule, in all zoeal stages. Moreover, the flexure of the third abdominal somite in the first zoea of *Athanas* also occurs in larvae of palaemonid species of the subfamily Pontoniinae, e.g., *Coralliocaris graminea* (Dana, 1852) and *Harpiliopsis beaupresii* (Audouin, 1826) (see Gurney 1938, the latter as *Harpilius beaupresii*), and *P. pandionis* (see Gore et al. 1981). As suggested by Gurney (1938), these larval characters

support the view that the Alpheidae are closely related to the Palaemonidae.

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